63rd Illinois Bituminous Conference

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# *Cold In-Place & Cold Central Plant Recycling Performance*


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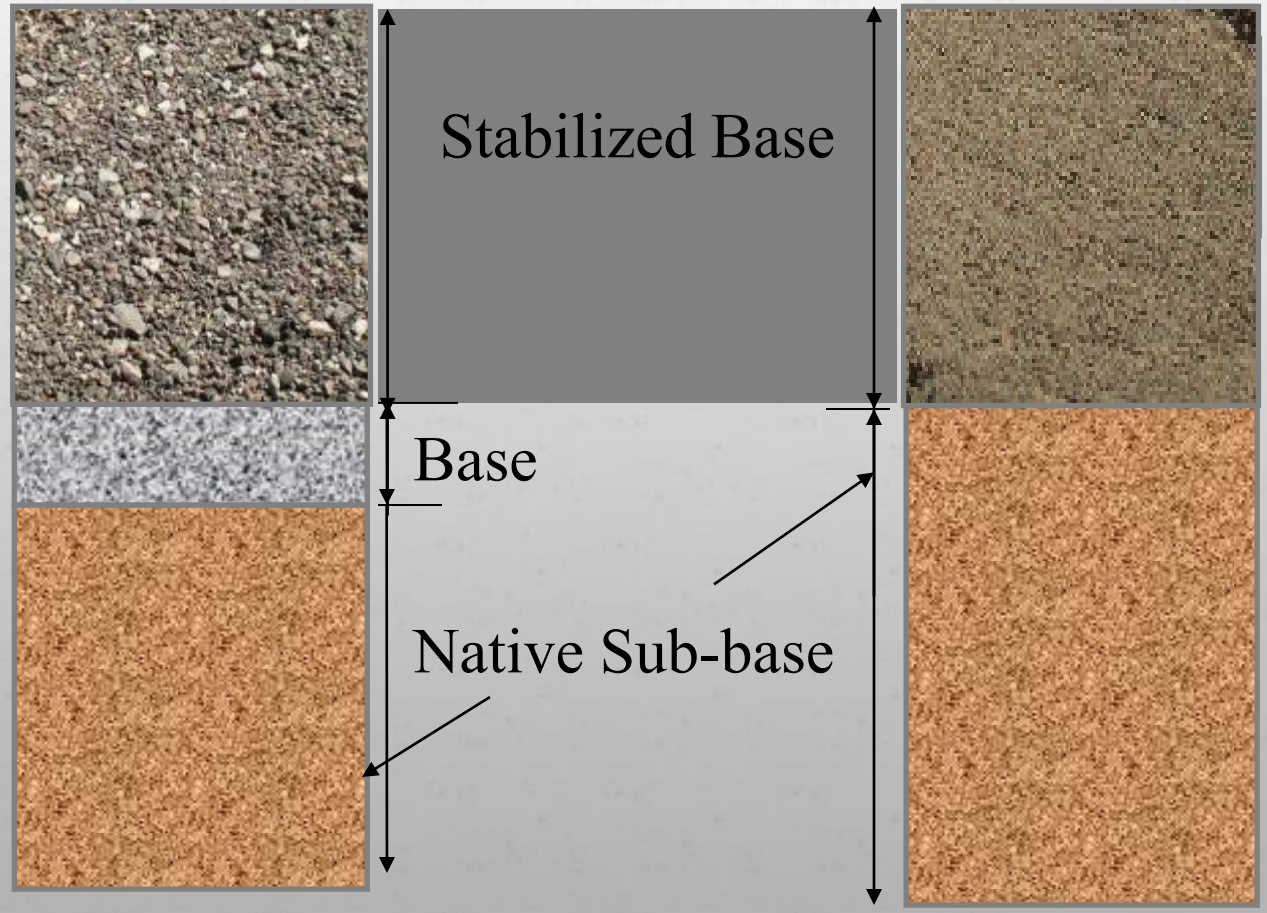
# *ARRA Disciplines*

ARRA™
Responsible Renewal. Reliable Results.

- **Cold Planing (CP)**
- **Hot In-place Recycling (HIR)**
- **Cold Recycling (CR)**
  - Cold In-place Recycling (CIR)
  - Cold Central Plant Recycling (CCPR)
- **Full Depth Reclamation (FDR)**
  - Soil & Base Stabilization

# Full Depth Reclamation

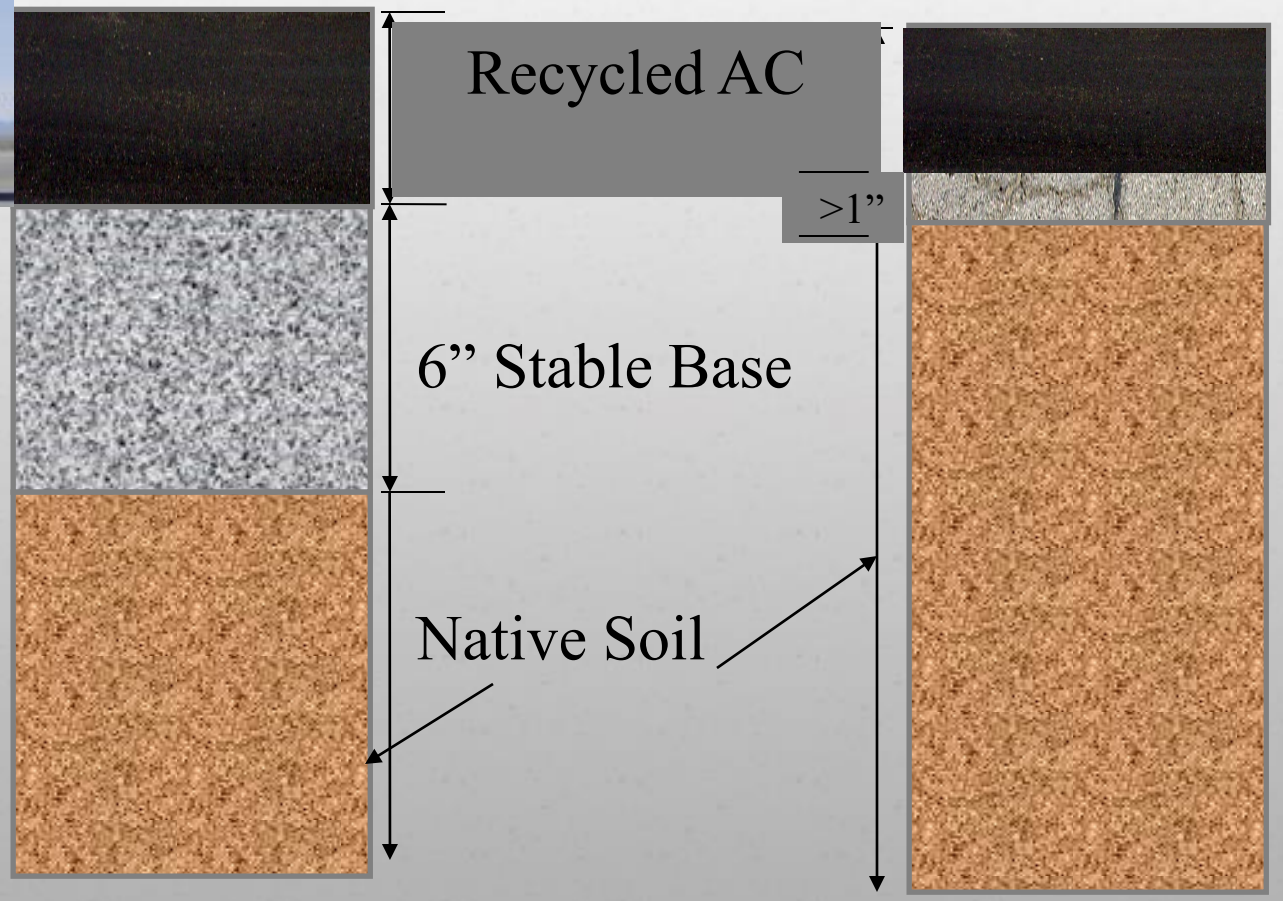
Improves existing materials in-place to provide greater structural support and reduction of imported material.



# Cold In-place Recycling

Recycle AC to:

- Stable Base
- Within 1” of less Supportive Material



# CIR Current Offerings

**Single Unit Train**

- Mixing and sizing done in cutter housing
- Additive calculated on volume

**Multi-Unit Train**

- Closed loop sizing with screen and crusher
- Additive by weight

# Cold Central Plant Recycling (CCPR)

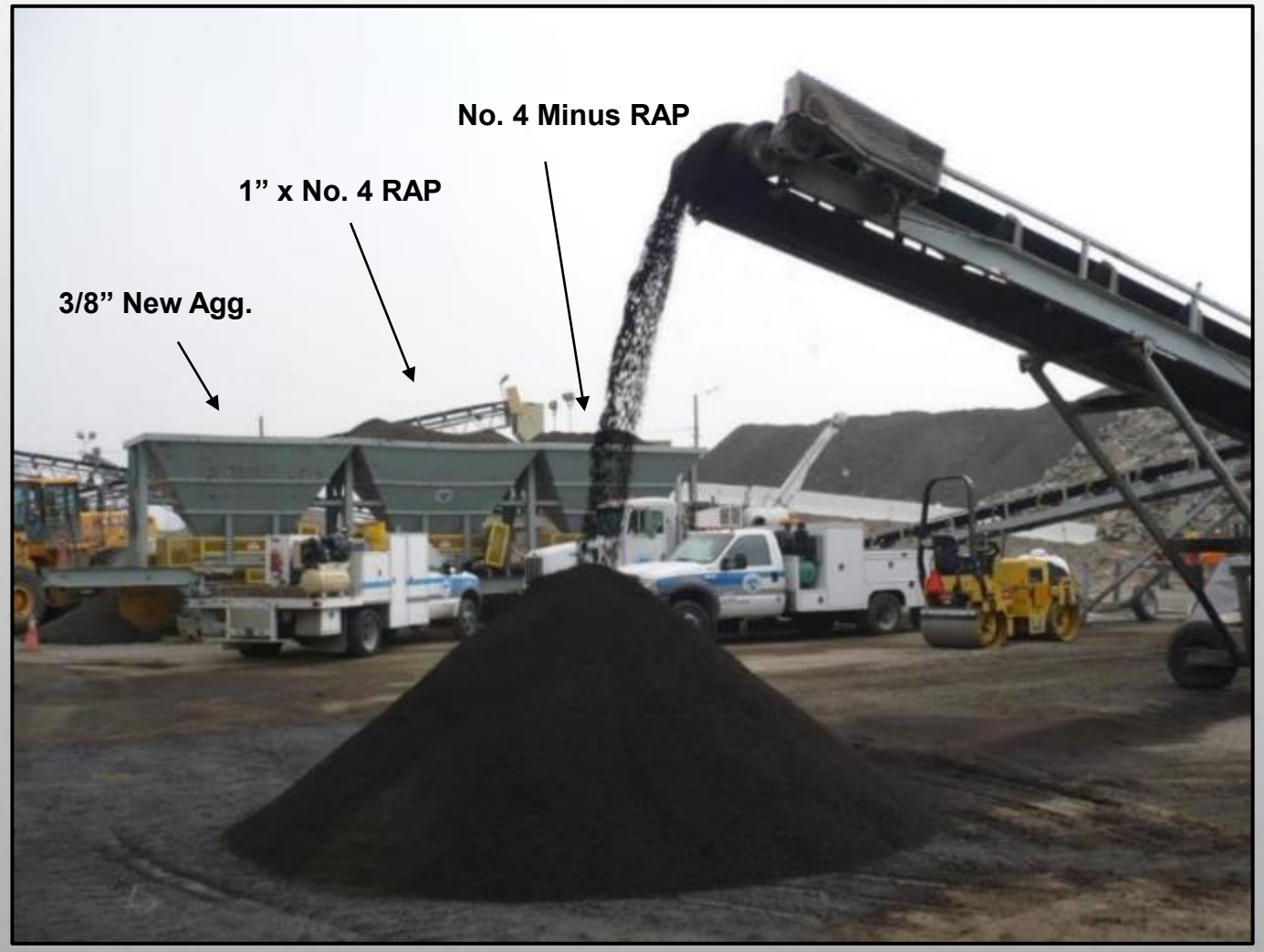
Clean Rap = New Pavement:

- **Stockpiled and kept clean**
- **Crushed RAP to gradation**
- **Mixed with bituminous recycling agent in central plant**
- **Transported to lay down area**
- **Paved as a recycled mix**
- **Compacted to specified density**
- **Readied for surface treatment**

***From RAP***

***to Pavement***

# You can fractionate RAP and add new aggregate if required



# *In-Place Recycling*

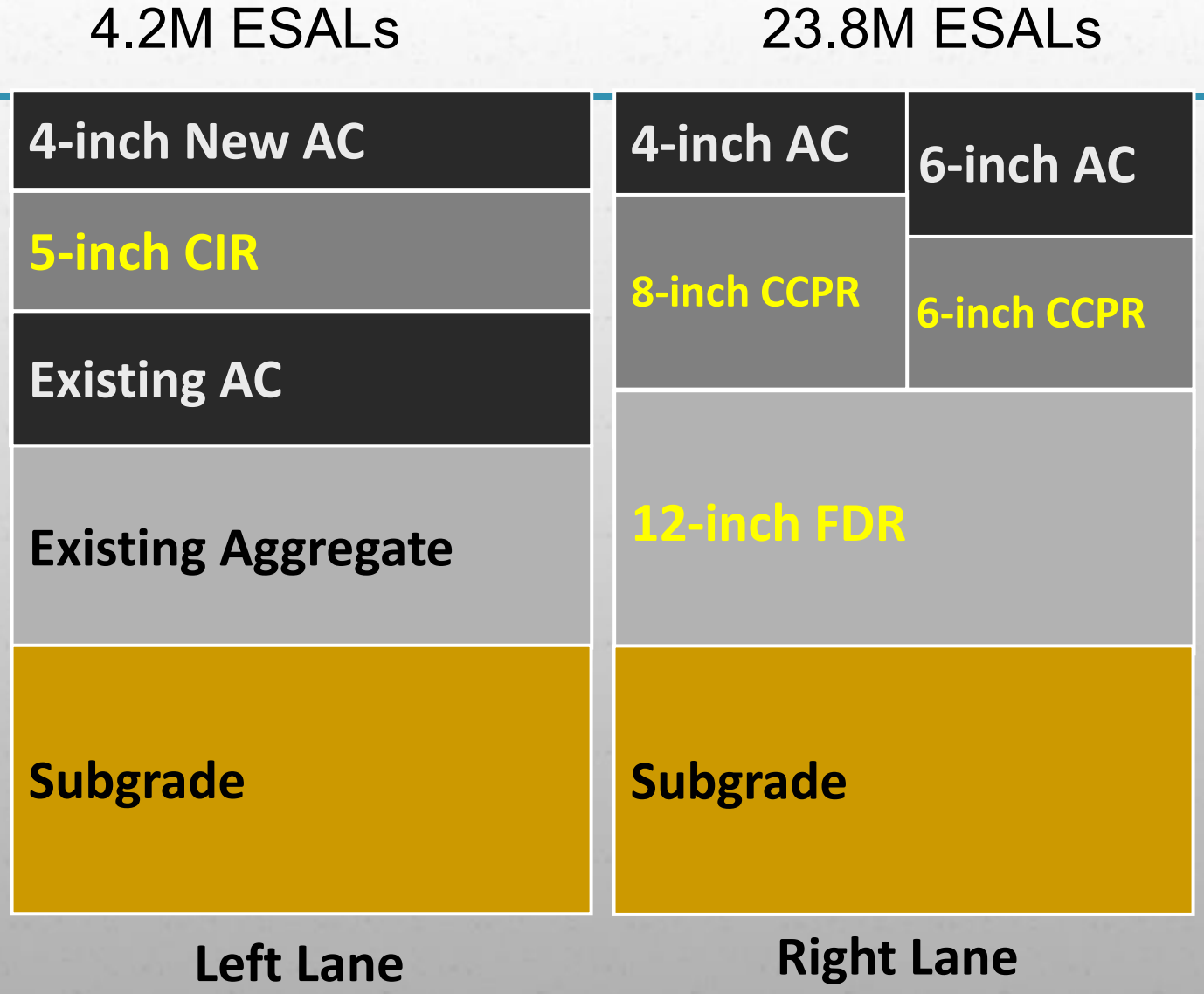
- Reuses 90-100% of existing materials, in-place
- Costs 20-50% less than traditional methods
- Produces up to 90% less greenhouse gasses
- Reduces user delays
  - 20 to 40% faster construction
- Proven Performance

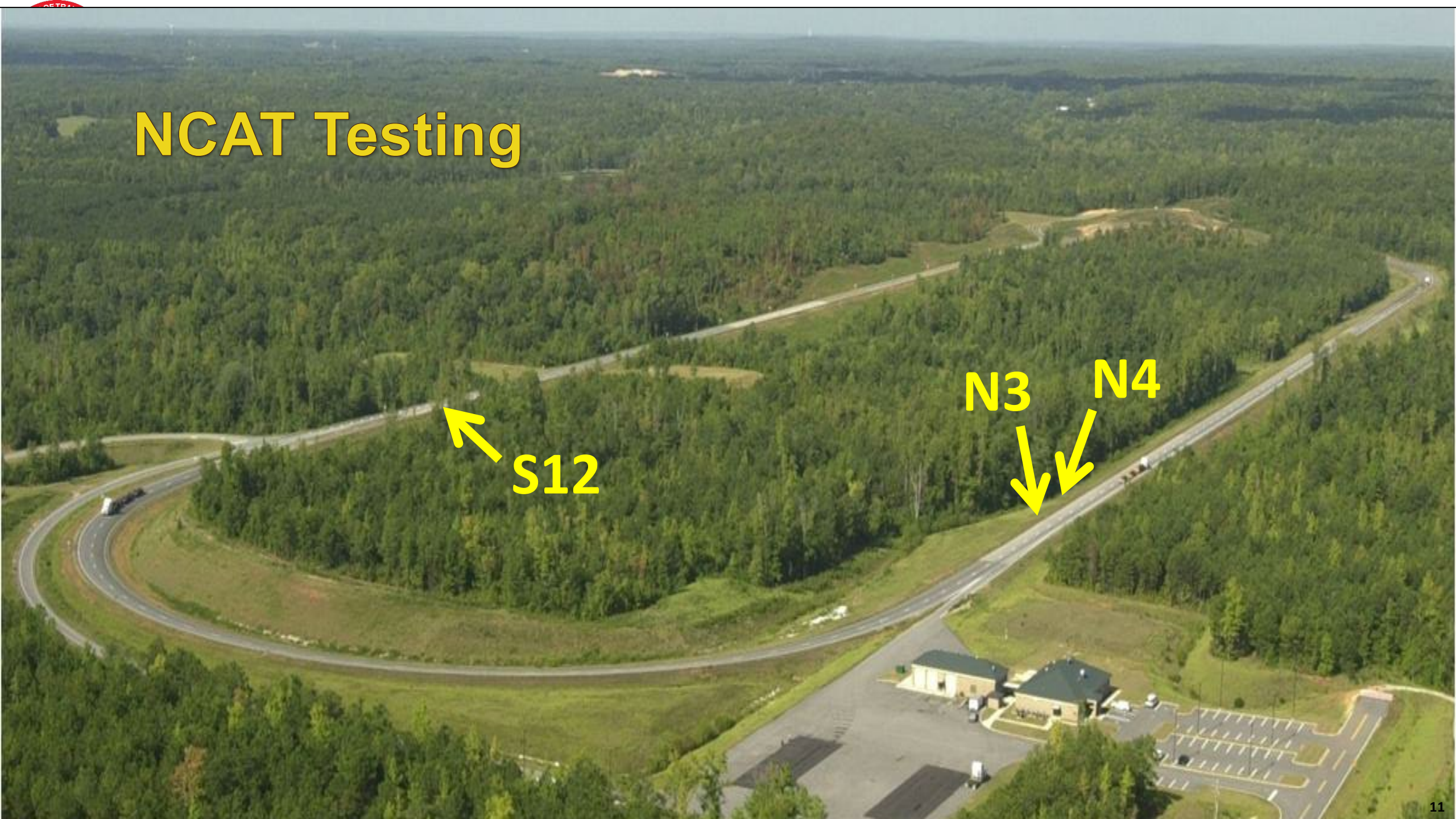
# I-81 Virginia

- MP 213.7-217.0, southbound direction
- 2019 AADT = 24,000 vehicles per day with 30% trucks
- Paving between April and June 2011
- Calculated loading as of May 2022
  - 23.8 million ESALs (right lane)
  - 4.2 million ESALs (left lane)

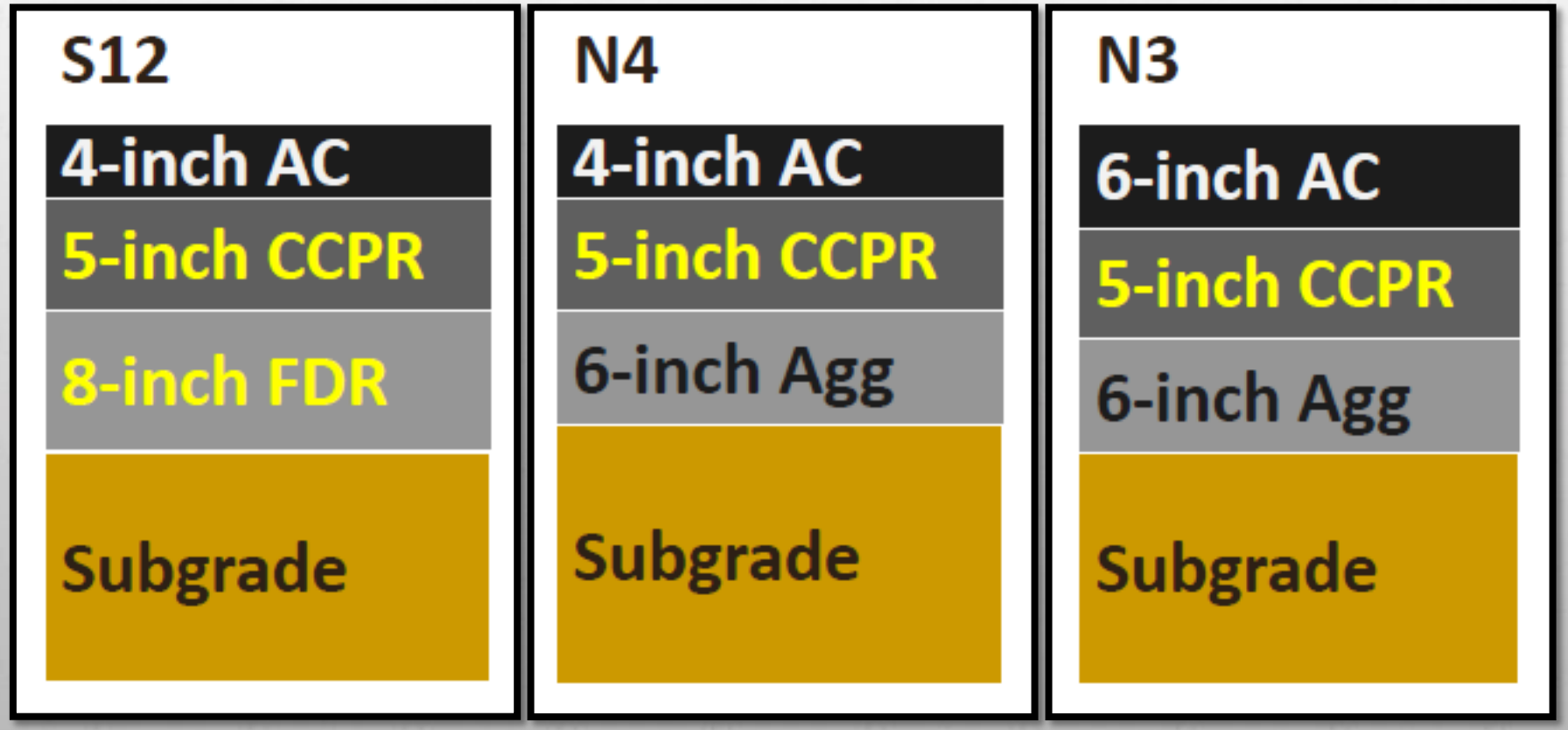
# I-81

- Rut depth 0.1 inch both lanes
- Left Lane IRI < 60 in/mile
- Right Lane IRI < 50 in/mile




NCAT Testing
S12
N3
N4

# VDOT Sections with CCPR at NCAT Test Track

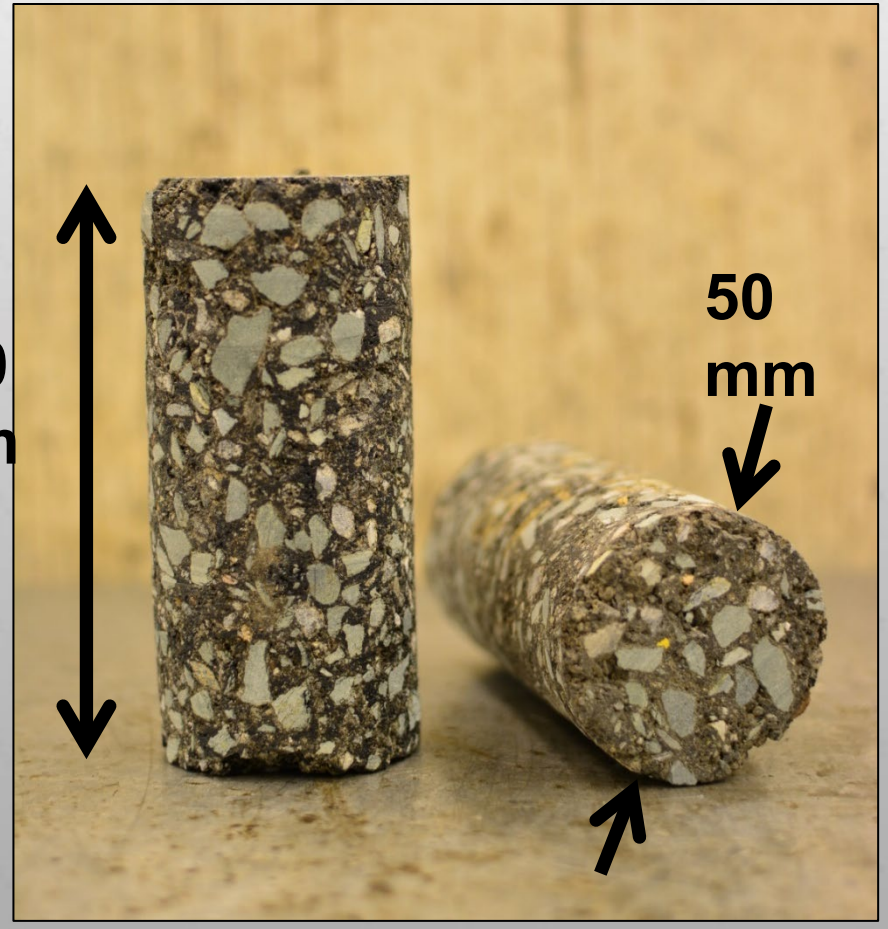


# NCAT Testing - Findings

- 6” AC section (N3) stopped after 20 million ESALs, no condition change
- 4” AC section (N4) currently at 35+ million ESALs
  - minor cracking (< 0.1% wheel path area)
- Calculated layer “a” coefficient 0.36 – 0.43 in N3 and N4
- CCPR+FDR section (S12) stopped after 30 million ESALs, no condition change
  - Rebuilt in 2022 to investigate re-recycling CCPR
  - Perpetual type performance

# Lab Testing

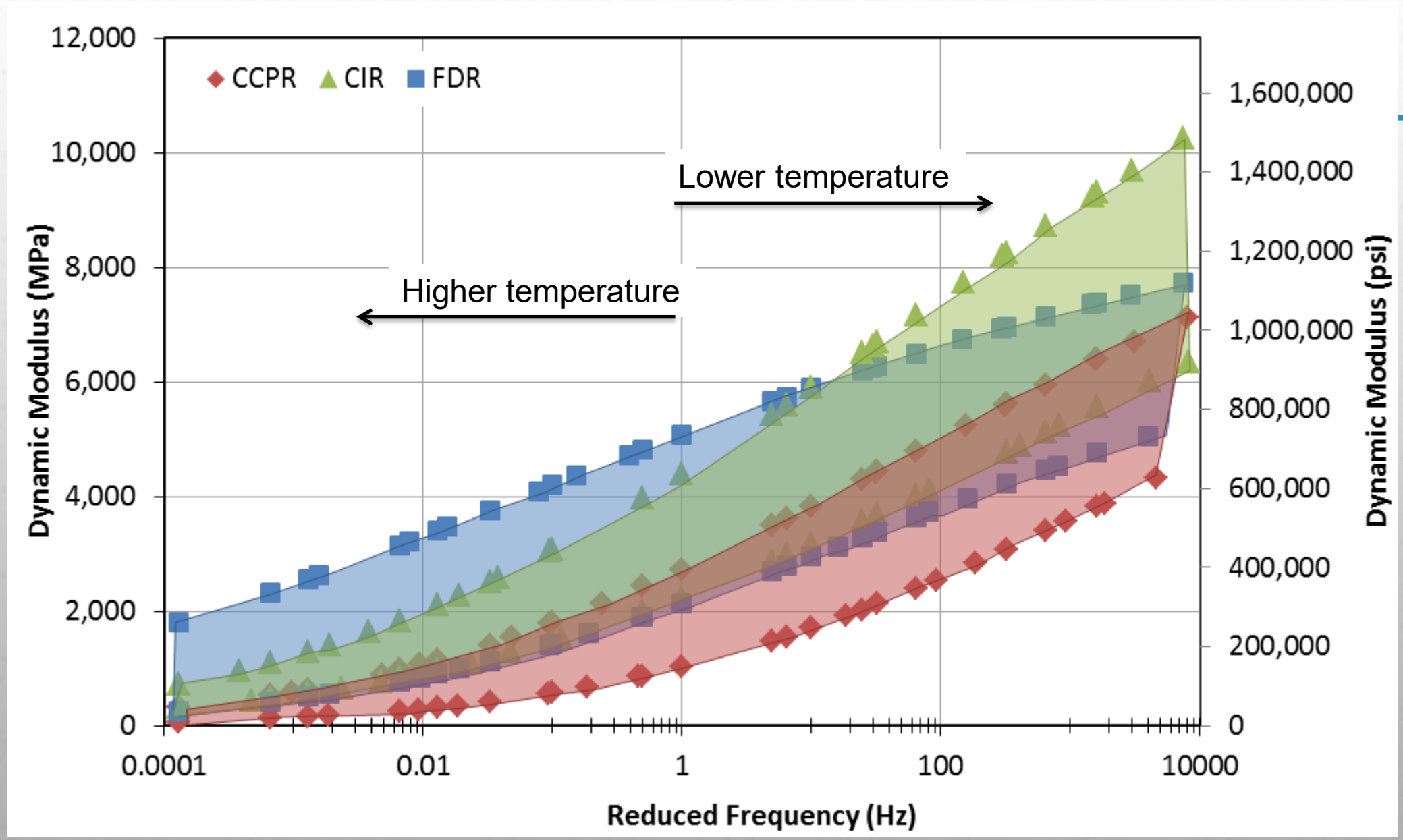
- NCHRP Project 09-51, Material Properties for CIR and FDR for Pavement Design
  - PI: University of MD

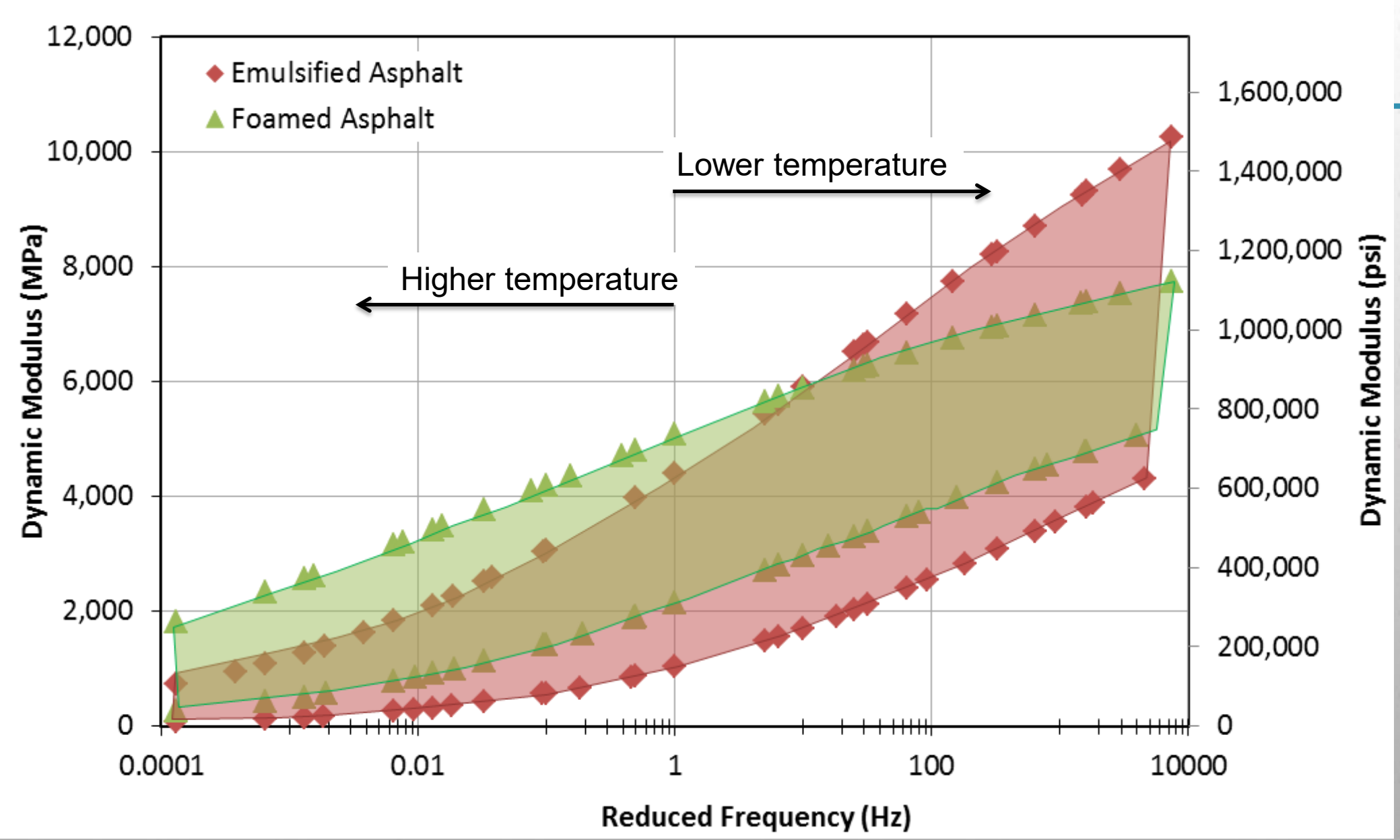


CIR

CCPR

FDR


CCPR
CIR
FDR
Lower temperature
Higher temperature
Dynamic Modulus (MPa)
Dynamic Modulus (psi)
Reduced Frequency (Hz)
12,000
10,000
8,000
6,000
4,000
2,000
0
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
0.0001
0.01
1
100
10000


Emulsified Asphalt
Foamed Asphalt
Lower temperature
Higher temperature
Dynamic Modulus (MPa)
Dynamic Modulus (psi)
Reduced Frequency (Hz)
12,000
10,000
8,000
6,000
4,000
2,000
0
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
0.0001
0.01
1
100
10000

# Lab Testing - Findings

- FDR has similar stiffness as CIR and CCPR
- No significant difference between foam and emulsion for CIR and CCPR
- Use of active fillers (cement or lime) had a positive influence after 1 year
  - *Wirtgen recommends 1% maximum cement foamed asphalt*
  - *ARRA recommends minimum 2.5:1 ratio residual asphalt to cement for emulsified asphalt*

# NCAT Lee Road 159 Preservation Study CCPR Base in Section L20

- 3/4 inch HMA Thin Lay over 5 inch CCPR
- 2% foamed asphalt, 1% cement
- Placed 2012, 10 years Over 1.6 M ESALs
- Performance
  - < 7% low severity cracking
  - < 3 mm Rutting
  - IRI increased from 120 – 142 in/mile

# MNRoad 70th Street

- Pre-reconstruction Avg. IRI 385 in/mile
- Existing road 4 inches over 6 inches Granular Base with clay subgrade


# MNRoad 70th Street

- 1 inch HMA Thin Lay
- 3 inches CCPR or CIR
- 1 inch old pavement and 6 inches Granular Base
- Clay subgrade
- 500 ft sections

| Section/Mix | Binder | Cracking | Rutting | IRI |
|---|---|---|---|---|
| 7003 CIR | 2.6% Foam 1% Cement | 184 ft | 3 mm | 75 |
| 7004 CIR | 2.8% Emulsion | 126 ft | 5 mm | 70 |
| 7005 CCPR | 3.5% Emulsion | 126 ft | 5 mm | 80 |
| 7007 CCPR | 2.3% Foam 1% Cement | 115 ft | 2 mm | 70 |

# SR 101 Indiana

- Project Background
  - 8-Mile Length
  - Avg. IRI 153 in/mile
  - 31% Roadway Poor Condition
  - Lack of Shoulders
- Proposed Solution
  - Widen Pavement from 20 to 26 Feet
  - Increase Subgrade Strength
  - Reconstruct Pavement

# SR 101 Indiana

- **Pavement Condition**
  - Widespread age-related distress and fatigue
  - Beyond point patching & mill & fill cost effective
  - 10+ Inches HMA
  - Delaminated/Unbound pavement layers
  - Asphalt stripping due to moisture infiltration

# SR 101 Solution: FDR + CCPR

- Milled off 8 inches of existing pavement
- Hauled and stockpiled at central location
- Crushed to 1.25 inch minus
- Produced CCPR mix

# SR 101 Solution: FDR + CCPR

- Trenched 3’ on each side
- Performed FDR and Spread and Compacted 26’ wide, 10”deep
- Utility Work Performed Prior to FDR

# SR 101: Emulsion CCPR Construction

- Placed 6” CCPR Mix
- 2.5% Engineered Emulsion
- Roadway was Profile Milled to correct cross slope
- Placed 2” 12.5 mm HMA surface mix
- Final section 89% Recycled Material

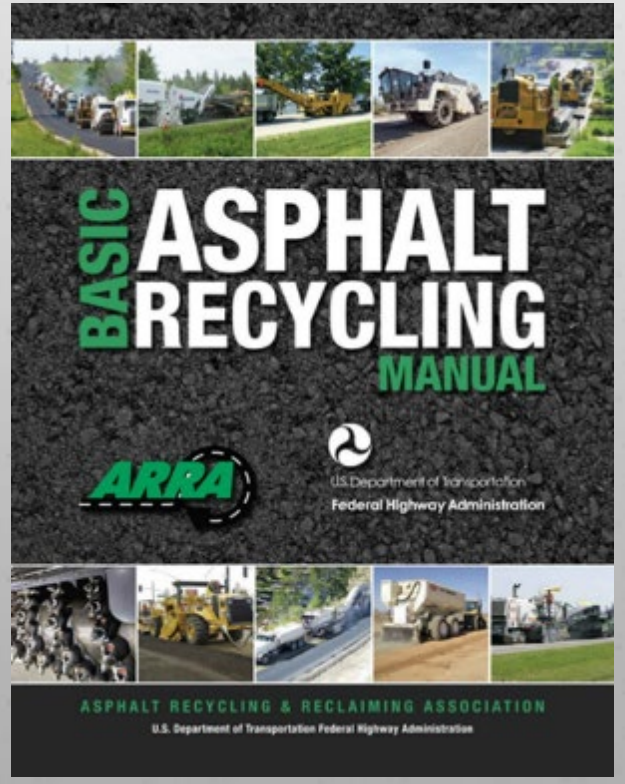
# SR 101: Milling & HMA Surfacing

- SR 101 – 8.62 miles or 17.24 lane miles
- FDR/CCPR Cost
  - $4,970,715 (awarded)
  - $288,325/lane mile
- Pavement Replacement
  - $11,939,980 (DOT estimate)
  - $692,574/lane mile
- Percent Difference: 58%

Source: Flora, Purdue Road School, 2020

# More Information

**Basic Asphalt Recycling Manual**

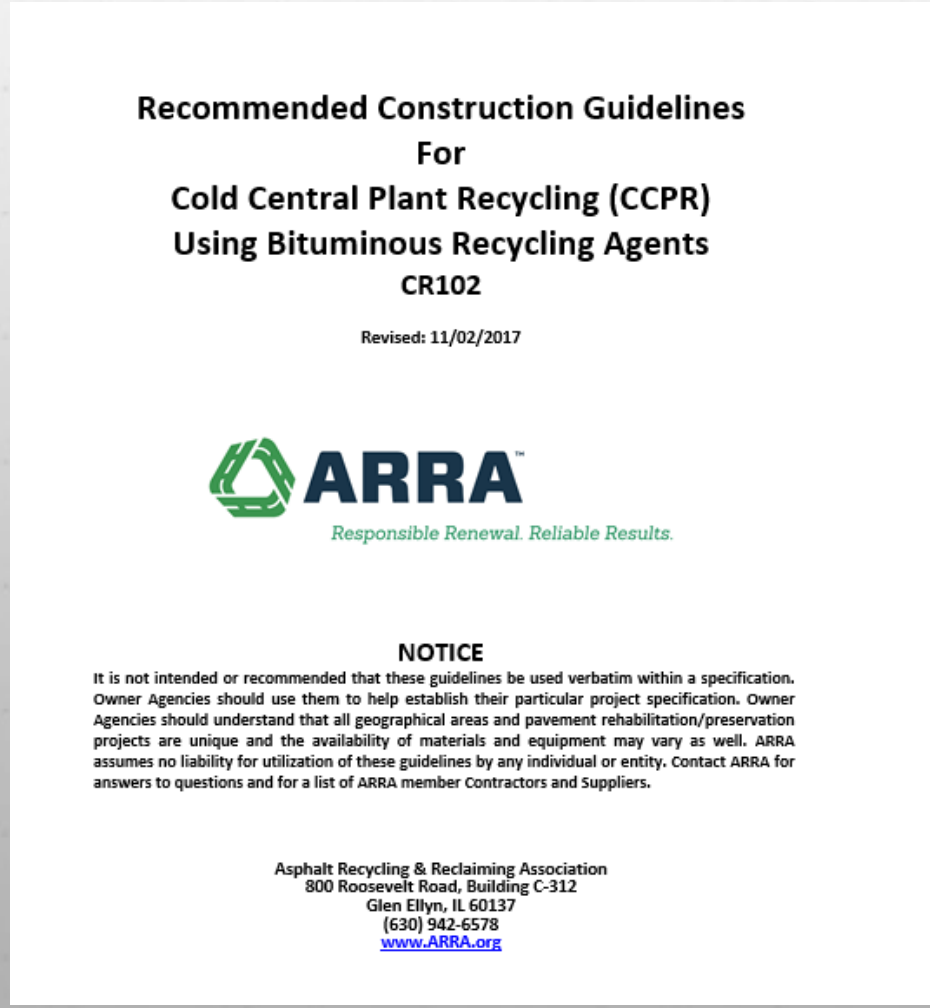



**www.roadresource.org**

# ARRA Best Practice Guidelines

- Series 100 Construction Best Practice Guidelines
- 200 Series Project Sampling & Mix Design Guidelines
- 300 Series QC Guidelines
  - Recommended Quality Control Checks and Remediation Actions
- Available for CIR, CCPR, FDR at:

  www.arra.org/page/Resources



Recommended Construction Guidelines
For
Cold Central Plant Recycling (CCPR)
Using Bituminous Recycling Agents
CR102

Revised: 11/02/2017

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NOTICE

It is not intended or recommended that these guidelines be used verbatim within a specification. Owner Agencies should use them to help establish their particular project specification. Owner Agencies should understand that all geographical areas and pavement rehabilitation/preservation projects are unique and the availability of materials and equipment may vary as well. ARRA assumes no liability for utilization of these guidelines by any individual or entity. Contact ARRA for answers to questions and for a list of ARRA member Contractors and Suppliers.

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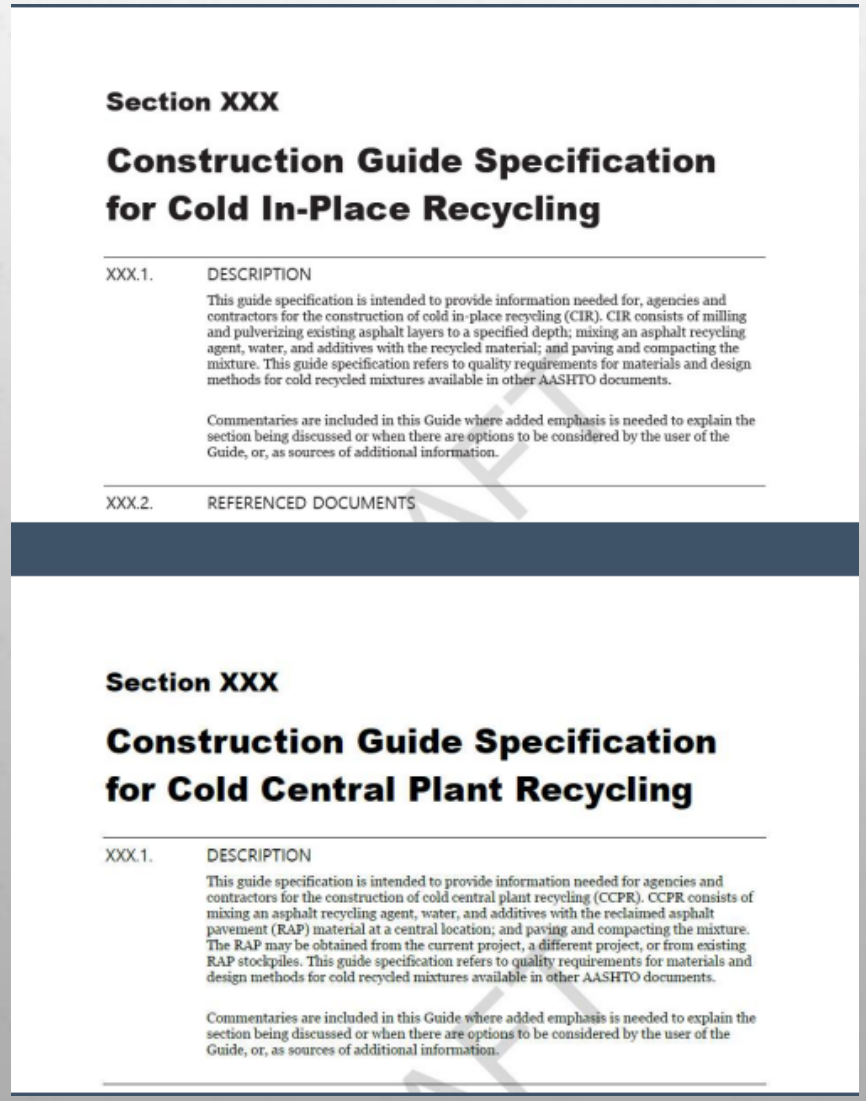
# NCHRP 14-43 Construction Guide Specifications for CCPR and CIR

- **Deliverables**
  - **Guide Specification in AASHTO format**
  - **Commentary**
  - **Best Practice Guideline**
  - ***QA Guide***
  - **Referenced ARRA's Best Practice Guidelines (CR101 & CR 301)**
- **In publication**



Section XXX

**Construction Guide Specification for Cold In-Place Recycling**

XXX.1. DESCRIPTION

This guide specification is intended to provide information needed for, agencies and contractors for the construction of cold in-place recycling (CIR). CIR consists of milling and pulverizing existing asphalt layers to a specified depth; mixing an asphalt recycling agent, water, and additives with the recycled material; and paving and compacting the mixture. This guide specification refers to quality requirements for materials and design methods for cold recycled mixtures available in other AASHTO documents.

Commentaries are included in this Guide where added emphasis is needed to explain the section being discussed or when there are options to be considered by the user of the Guide, or, as sources of additional information.

XXX.2. REFERENCED DOCUMENTS

Section XXX

**Construction Guide Specification for Cold Central Plant Recycling**

XXX.1. DESCRIPTION

This guide specification is intended to provide information needed for agencies and contractors for the construction of cold central plant recycling (CCPR). CCPR consists of mixing an asphalt recycling agent, water, and additives with the reclaimed asphalt pavement (RAP) material at a central location; and paving and compacting the mixture. The RAP may be obtained from the current project, a different project, or from existing RAP stockpiles. This guide specification refers to quality requirements for materials and design methods for cold recycled mixtures available in other AASHTO documents.

Commentaries are included in this Guide where added emphasis is needed to explain the section being discussed or when there are options to be considered by the user of the Guide, or, as sources of additional information.

# Summary

- CIR & CCPR are economical and sustainable construction and maintenance procedures
- CIR is best suited for cracked pavements with sound bases
- CCPR can be considered anywhere one would place multi-lift HMA
- CIR & CCPR require a wearing surface


# Thank You

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